

What Is Claimed Is:

1. A manufacturing method of a fuel injection valve that is equipped, on part of the circumference of an injection hole outlet opening, with a restriction wall which restricts the movement of fuel so that the fuel, injected from the injection hole and given a circling force, attains a component along the circling direction; wherein

of the two ends of the wall on the circumference, there is provided a wall that extends, with its height along the direction of the injection hole center axis, from one end located in the upstream of the circling direction of the fuel and parts, while extending from the end, from the edge of the injection hole outlet opening; and

when, at least, either the height of the wall or the angle between a direction along which the wall extends from the end perpendicularly to the injection hole center axis and a line which connects the two ends on the circumference of the restriction wall is changed, at least either one of the two ends is changed of its position on the circumference.

2. A manufacturing method of a fuel injection valve that is equipped, on part of the circumference of an injection hole outlet opening, with a restriction wall which restricts the movement of fuel so that the fuel,  
5 injected from the injection hole and given a circling force, attains a component along the circling direction; wherein

of the two ends of the wall on the circumference, there is provided a wall that extends from one end  
10 located in the upstream of the circling direction of the fuel and parts, while extending, from the edge of the injection hole outlet opening; and  
fuel injection valves with different spray profiles are manufactured by varying an angle, formed between a  
15 direction along which the wall extends from the end perpendicularly to the injection hole center axis and a line which connects the two ends on the circumference of the restriction wall, from 180 degrees.

20  
3. A manufacturing method of a fuel injection valve according to Claim 1 or 2, wherein

the restriction wall and the wall, which parts from the edge of the injection hole outlet opening  
25 while extending from the end of the restriction wall,

form a continued wall.

4. A manufacturing method of a fuel injection valve according to Claim 1, wherein

5 the fuel injection valve generates a spray profile that contains a concentrated spray portion and a thin spray portion, when viewed along the cross section perpendicular to the injection hole center axis of the injected fuel, and the positional relation between the  
10 concentrated spray area and the thin spray area is changed by varying the height or angle, and position.

5. A manufacturing method of a fuel injection valve according to Claim 2, wherein

15 the fuel injection valve generates a spray profile that contains a concentrated spray portion and a thin spray portion, when viewed along the cross section perpendicular to the injection hole center axis of the injected fuel, and the positional relation between the  
20 concentrated spray area and the thin spray area is changed by varying the angle.

6. A fuel injection valve that is equipped, on part of the circumference of an injection hole outlet  
25 opening, with a restriction wall which restricts the

movement of fuel so that the fuel, injected from the injection hole and given a circling force, attains a component along the circling direction; wherein

of the two ends of the wall on the circumference,  
5 there is provided a wall that extends, with its height along the direction of the injection hole center axis, from one end located in the upstream of the circling direction of the fuel and parts, while extending from the end, from the edge of the injection hole outlet  
10 opening; and

an angle, formed between a direction along which the wall extends from the end perpendicularly to the injection hole center axis and a line which connects the two ends on the circumference of the restriction  
15 wall, is made smaller than 180 degrees, when measured from the direction of the wall towards the line in the opposite direction of the circling of the fuel, viewing the tip of the fuel injection valve with the injection hole opening from the downstream of the  
20 spray injected from the injection hole.

7. A fuel injection valve that is equipped, on part of the circumference of an injection hole outlet opening, with a restriction wall which restricts the  
25 movement of fuel so that the fuel, injected from the

injection hole and given a circling force, attains a component along the circling direction; wherein

of the two ends of the wall on the circumference, there is provided a wall that extends, with its height  
5 along the direction of the injection hole center axis, from one end located in the upstream of the circling direction of the fuel and parts, while extending from the end, from the edge of the injection hole outlet opening;

10 an angle, formed between a direction along which the wall extends from the end perpendicularly to the injection hole center axis and a line which connects the two ends on the circumference of the restriction wall, is made smaller than 180 degrees, when measured  
15 from the direction of the wall towards the line counterclockwise, viewing the tip of the fuel injection valve with the injection hole opening from the downstream of the spray injected from the injection hole; and

20 an angle, formed between a line which connects the end located in the downstream of the restriction wall in the circling direction of the fuel and the injection hole center and a line which connects the end located in the downstream of the restriction wall  
25 in the circling direction of the fuel and the

injection hole center, is made greater than 180  
degrees, when measured from the line towards the  
direction counterclockwise, viewing the tip of the  
fuel injection valve with the injection hole opening  
5 from the downstream of the injected fuel.

8. A fuel injection valve that is equipped, on part  
of the circumference of an injection hole outlet  
opening, with a restriction wall which restricts the  
10 movement of fuel so that the fuel, injected from the  
injection hole and given a circling force, attains a  
component along the circling direction; wherein

of the two ends of the wall on the circumference,  
there is provided a wall that extends, with its height  
15 along the direction of the injection hole center axis,  
from one end located in the upstream of the circling  
direction of the fuel and parts, while extending from  
the end, from the edge of the injection hole outlet  
opening; and

20 an angle, formed between a direction along which  
the wall extends from the end perpendicularly to the  
injection hole center axis and a line which connects  
the two ends on the circumference of the restriction  
wall, is made greater than 180 degrees, when measured  
25 from the direction of the wall towards the line in the

opposite direction of the circling of the fuel,  
viewing the tip of the fuel injection valve with the  
injection hole opening from the downstream of the  
spray injected from the injection hole.

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9. A fuel injection valve that is equipped, on part  
of the circumference of an injection hole outlet  
opening, with a restriction wall which restricts the  
movement of fuel so that the fuel, injected from the  
10 injection hole and given a circling force, attains a  
component along the circling direction; wherein

of the two ends of the wall on the circumference,  
there is provided a wall that extends, with its height  
along the direction of the injection hole center axis,  
15 from one end located in the upstream of the circling  
direction of the fuel and parts, while extending from  
the end, from the edge of the injection hole outlet  
opening;

an angle, formed between a direction along which  
20 the wall extends from the end perpendicularly to the  
injection hole center axis and a line which connects  
the two ends on the circumference of the restriction  
wall, is made greater than 180 degrees, when measured  
from the direction of the wall towards the line in the  
25 opposite direction of the circling of the fuel,

viewing the tip of the fuel injection valve with the injection hole opening from the downstream of the spray injected from the injection hole; and

an angle, formed between a line which connects the end located in the downstream of the restriction wall in the circling direction of the fuel and the injection hole center and a line which connects the end located in the downstream of the restriction wall in the circling direction of the fuel and the injection hole center, is made smaller than 180 degrees, when measured from the line towards the direction in the opposite direction of the circling of the fuel, viewing the tip of the fuel injection valve with the injection hole opening from the downstream of the injected fuel.

10. An internal combustion engine in which fuel is injected into a cylinder, using a fuel injection valve equipped with an injection hole directed towards the cylinder inside, the injected fuel is ignited, using an ignition system equipped with an ignition device in the cylinder, and the piston installed in the cylinder is reciprocated; wherein

the fuel injection valve equipped there is a fuel injection valve according to any one of Claims 6 to 9;



and

of the two ends of the restriction wall, the fuel injection valve is so installed that the movement direction of the fuel comes approximately together with the direction of the ignition device along the tangential direction at one end located in the downstream of the circling direction.

11. An internal combustion engine in which fuel is injected into a cylinder, using a fuel injection valve equipped with an injection hole directed towards the cylinder inside, the injected fuel is ignited, using an ignition system equipped with an ignition device in the cylinder, and the piston installed in the cylinder is reciprocated; wherein

the fuel injection valve equipped there is a fuel injection valve according to any one of Claims 6 to 9;

the fuel injection valve is installed close to the ignition device; and

of the two ends of the restriction wall, the fuel injection valve is so installed that the movement direction of the fuel comes approximately together with the direction of the ignition device along the tangential direction at one end located in the upstream of the circling direction.

12. An internal combustion engine in which fuel is injected into a cylinder, using a fuel injection valve equipped with an injection hole directed towards the cylinder inside, the injected fuel is ignited, using  
5 an ignition system equipped with an ignition device in the cylinder, and the piston installed in the cylinder is reciprocated; wherein

the fuel injection valve equipped there is a fuel injection valve according to any one of Claims 6 to 9;

10 the fuel injection valve is installed close to the ignition device; and

the fuel injection valve is so installed that a thin spray area of the fuel injected from the fuel injection valve is directed towards the ignition  
15 device.

13. An internal combustion engine according to Claim 11 or Claim 12, wherein

the fuel injection valve and the ignition device  
20 are installed between a suction valve for sucking air into the cylinder and an exhaust valve for discharging exhaust from the cylinder.

14. A fuel injection valve according to any one of  
25 Claims 6 to 9, wherein

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